System Inspector Manual
CHAPTER 3 - NON-CONVENTIONAL TREATMENT SYSTEMS

Title 5 describes design and construction standards for conventional septic tank/soil absorption systems; however, it also provides quite a bit of flexibility for the testing, approval and use of non-conventional systems, including innovative and alternative (I/A) technology. In fact, certain non-conventional systems are required for systems located in nitrogen sensitive areas with design flows greater than 2000 gpd or with design flows that exceed certain density restrictions. As such, System Inspectors should become familiar with these technologies. This section will provide a brief overview of several of these systems. It is not intended to provide detailed information on each type of system; however, design guidances for Recirculating Sand Filters and pressure distribution are provided as appendices to this manual. It is strongly recommended that any System Inspector who anticipates dealing with these types of systems seek appropriate training in the operation and maintenance of them. Otherwise, the inspector, as a matter of ethics, should not inspect these systems.

Recirculating Sand Filters

Title 5 approves recirculating sand filters (RSF) as nitrogen reducing systems and sets the standards of performance for other enhanced treatment technologies.

Recirculating sand filters were developed in the early 1970's in Illinois as a modification to the established technology of intermittent (single pass) sand filters. They are a simple, compact method of providing a higher level of treatment of septic tank effluent as compared to conventional soil absorption systems. RSFs are especially attractive for systems with higher flows or high strength wastes since high rates of failure have been associated with large conventional soil absorption systems nationwide and the higher degree of treatment afforded by RSFs can help insure better treatment, reliability and longevity of these systems. In addition, properly designed RSFs offer nitrogen removal that is important in nitrogen sensitive areas.

A typical RSF system consists of a septic tank, a recirculating tank and a sand filter. Operation of the system begins with primary treatment in the septic tank. The treated septic tank effluent then flows to the recirculating tank. In doses controlled by both a timer and a high level float switch, a mixture of fresh influent and recirculated, partially treated filtrate is applied to a sand filter bed of specified media. The wastewater is dispersed over the media bed through a pressure distribution network, and as the wastewater trickles downward through the sand/gravel media, pollutant reduction occurs through biological treatment on the surface of the media particles.

The treated wastewater (filtrate) is collected at the bottom of the filter, and discharges, either by gravity or by pressure, to the recirculation tank. There it mixes with fresh influent, a portion is discharged, and the cycle begins again. Customarily, a float-activated valve is used to control recirculation and discharge. Treated wastewater is discharged to an approved soil absorption system.

An important design factor in the sand filter dosing is the recirculation ratio (RR). The RR is defined as the ratio of the total flow through the sand filter to the forward (or average design) wastewater flow. Typical RR values for an RSF system range between 3:1 to 5:1. Besides determining the amount of wastewater to be pumped, the RR helps avoid odors by ensuring that the majority of wastewater applied to the sand filter is previously treated wastewater.

Typical effluent values for conventional systems for BOD_5 range from 28-84 mg/L and for TSS range from 18-53 mg/L. RSFs, properly operated and maintained can consistently achieve BOD_5 and TSS values under 10 mg/L. Depending upon design, nitrogen removal in RSFs can range from 40%-80% resulting in concentrations ranging from 10-30 mg/L.

310 CMR 15.202(4)(i) requires that RSFs be inspected annually by a Massachusetts Registered Professional Engineer. In addition, the Board of Registration of Operators of Wastewater Treatment Facilities will require that the owner/operator of RSFs execute a contract or maintenance agreement with a certified operator of appropriate grade. As such, RSFs will be subject to a higher level of oversight than conventional onsite sewage disposal systems. Appendix A provides much more detailed information on the design, operation and maintenance of RSFs and provides information on operation, maintenance and inspection parameters.

Pressure dosing

Uniform application of septic tank effluent throughout the leaching system is an important factor in the proper operation of an onsite subsurface sewage disposal system. Gravity application does not provide uniform distribution and can create localized ponding within the leaching system. This can inhibit proper treatment and is of special concern in larger systems where failure rates have been documented to be higher than in smaller, residential systems. Pressure distribution networks can be employed as a means of achieving uniform application and can overcome the limitations of gravity distribution systems. Pressure distribution is required for systems with a design flow in excess of 2,000 gpd.

The pressure distribution network usually consists of 1 to 3 inch perforated laterals connected by a central or end manifold of larger diameter. Pumps pressurize the network and are sized to provide relatively uniform distribution. Because the perforations of the distribution laterals are loaded at approximately the same pressure they will discharge at approximately the same rate.

In-line Pressure: The pressure network should be designed to provide a minimum of 2 to 3 feet of head at the distal ends of the laterals. The variation in flow rate between two orifices in the same lateral should not exceed 10% and the variation in flow between any two orifices in the network should not exceed 15%.

Perforation Spacing: Uniform distribution can best be achieved by providing as many uniformly spaced perforations as is practical. Minimum perforation size should be ¼ in. since smaller perforations will tend to clog. It is recommended that the spacing between perforations should not exceed five (5) feet; however, shorter spacings are more desirable. In bed systems, the perforations between any two laterals should be staggered so that they lie on the vertices of equilateral triangles.

Manifolds: In order to minimize flow variation, the manifold should have as small a volume as possible. Also, in order to minimize leakage as the network is pressurized, the manifold should be installed below the distribution laterals so that it fills and pressurizes before discharge from the perforations occurs.

Appendix B provides detailed design procedures for pressure distribution systems. Generally, inspections of these systems will be limited to checking that the pumps are operating as required unless there are other indications of gross failure of the soil absorption system.

Composting Toilets

Composting toilets accept toilet waste only in a waterless or semi-waterless unit. Human waste is decomposed in a composting vessel and the final compost is removed periodically. A disposal system (comprised of a septic tank and soil absorption system) is required for graywater.

Amphidrome Process

The Amphidrome Process makes use of an innovative configuration of Tetra Technology's Colox and Denite (denitrification) processes. Colox is an upflow, packed bed aerobic biological treatment process. It utilizes fixed-film granular media that has a high specific surface area for the attachment of bacteria. This allows the development of a high density biomass in a very small space. As a result the hydraulic detention time is quite long. The Denite filter system is a columnar biological denitrification process that employs microorganisms growing on the fixed surfaces of the filter media to convert oxidized nitrogen in the wastewater to gaseous nitrogen under anoxic conditions. In order to accelerate the denitrification reaction, a carbon source is added to the nitrified wastewater to supply the energy and carbon required by the denitrifiers.

AWT Bioclere System

The Bioclere units utilize a trickling filter concept for wastewater treatment. The unit is added to a conventional system between the septic tank and the soil absorption system. The filter consists of a bed of highly permeable plastic media to which microorganisms are attached and through which septic tank effluent is trickled. The base of the unit serves as a final settling basin which discharges to a traditional leaching area. Nitrified effluent from the settling basin can be returned (pumped) to the septic tank for passive denitrification.

Cromaglass

The Cromaglass System is a Sequencing Batch Reactor (SBR). The unit is a fiberglass tank separated into three chambers. The raw wastewater enters the first chamber. The large particles are retained while the liquid and small particles flow through the retention screens to the second chamber that serves as the primary aeration chamber and provides biological treatment. Agitation and mixing are provided by an aeration process. At preset intervals a batch of processed wastewater is transferred to the third chamber that acts as a settling basin. After approximately one hour of quiescent settling, a portion of the treated effluent is discharged to the soil absorption system.

Eljen In-Drain System

The Eljen In-Drain leaching system provides an alternative leaching system that does not require stone. The In-Drains are constructed of recycled cuspated plastic core and a high grade non-woven biofabric. The biofabric is continuous and wrapped over and under each piece of plastic core. Each In-Drain unit is banded using high strength plastic strapping to provide a final dimension of 3 feet wide by 4 feet long by 7 inches high (3' W x 4' L x 7" H). The In-Drain units are placed on top of 6 inches of concrete sand end to end and the distribution pipe is placed directly on top of the units. The system is then covered with a geotextile fabric. It is intended to be used as a leaching system without stone. When used in a trench configuration, the Model B provides an effective leaching area of 6.2 square feet per linear foot.

Envirochamber

The Envirochamber is an open bottom leaching chamber molded from high density polyethylene. It is intended to be used as a leaching system without stone. In a trench configuration, the standard Envirochamber provides an effective leaching area of 26.04 square feet and each high capacity Envirochamber provides an effective leaching area of 32.29 square feet.

Infiltrator

The Infiltrator is an open bottom leaching chamber molded from high density polyethylene. It is intended to be used as a leaching system without stone. When used in a trench configuration, each Infiltrator provides an effective leaching area of 28.12 square feet.

KROFTA Compact Clarifier

The KCC 5-2.25 Compact water clarification system is a wastewater clarifier capable of handling flows up to 5 gallons per minute. The KCC clarifier combines the technology of flotation with sand filtration in a compact package in order to provide additional removal of wastewater contaminants such as BOD_5, TSS, phosphorus and nitrogen. The system contains a self-automated control panel that operates both the filtration process and a periodic backwash allowing the system to clean itself.

RUCK System

The RUCK system is a passive denitrifying system designed to treat domestic sewage by means of a parallel septic tanks (receiving graywater and blackwater, respectively), a nitrifying (RUCK) filter and a conventional subsurface leaching system. By mixing the nitrified effluent from the RUCK filter with graywater, enhance nitrogen removal occurs.

SANECO Intermittent Sand Filter

Intermittent sand filters are beds of medium to coarse sands, usually 24 to 36 inches deep and underlain with gravel containing underdrains. Effluent from the septic tank is intermittently applied to the surface and purification of the effluent occurs as it infiltrates and percolates through the sand bed. Underdrains collect the filtrate and convey it to the leaching field.

Smith and Loveless Single Home and Modular FAST Systems

The FAST (Fixed Activated Sludge Treatment) process consists of primary settling zone and an aerobic biological zone. Solids are trapped in the primary zone where they settle. In the aerobic zone, the bacteria attach themselves to the surface of a submerged media bed and feeds on the sewage as it circulates throughout the system. Final discharge is to a conventional leaching system.

Shared systems

Title 5 allows the use of shared systems for repairs, upgrades and new construction. The implication for System Inspectors is that such systems are required to be inspected annually and that, as larger systems, the inspector may come into contact with a variety of systems ranging from conventional to RSFs to innovative or alternative systems. The System Inspector again should be cautioned to limit inspections to those types of systems with which he or she is familiar. This is an issue that not only relates to ethical practice, but also to the question of inspector's liability.